NERRS Science Collaborative Progress Report for the Period March 1, 2013 through August 31, 2013

Project Title: Collaborative Planning for Climate Change Adaptation: A Case Study in Great Bay National Estuarine Research Reserve (now known as the Climate Adaptation Planning for Exeter (CAPE) project)
Principal Investigator(s): Paul Kirshen, Semra Aytur, David Burdick, Michele Holt-Shannon, Steve Jones, Bruce Mallory, Robert Roseen, Paul Stacey, Cameron Wake
Project start date: September 1, 2012
Report compiled by: Paul Kirshen
Contributing team members and their role in the project: Semra Aytur (Collaboration Lead), Michele Holt-Shannon (Stakeholder Assessment Lead), Rob Roseen (Applied Science Investigator (ASI), David Burdick (ASI), Steve Jones (ASI), Paul Stacey (Outreach), Paul Kirshen (Project Coordinator, PI, ASI)), Steve Miller (Outreach), Chris Keely (Outreach)

A. Progress overview: State the overall goal of your project, and briefly summarize in one or two paragraphs, what you planned to accomplish during this period and your progress on tasks for this reporting period. This overview will be made public for all reports, including confidential submissions.

Great Bay National Estuary Research Reserve (GBNERR) is located in southeastern New Hampshire (NH) and includes 20,172 acres of open water, wetlands, and upland. The watershed that drains into the Reserve of 1,084 square miles is heavily forested with wetlands but also has 9 % of its area urban, which is increasing. The major climate change stressors in the region include increases in air and water temperatures, the frequency of extreme hot days and sea levels, and changes in precipitation and runoff patterns, and more intense storms. GBNERR has clearly articulated its concern about the impacts of climate change on local communities whose activities impact the watershed. The UNH team is undertaking a collaborative planning effort to develop an integrated climate change adaptation plan for a case study area with a range of land uses on a major tributary and estuary to Great Bay where climate change will exacerbate its present challenges with 1) storm water, 2) nonpoint source pollution, 3) land use, and 4) the protection and restoration of downstream marshes and fisheries. These climate change stressors also have the potential to impact public health. Because the stressors in the case study area are intertwined, they can be most efficiently and effectively managed in an integrated fashion.

The case study area is the portion of the Town of Exeter, NH in the Exeter/Squamscott River Basin, which includes most of the town's area and is just upstream of Great Bay as shown in Figure 1 (end of report). However, because portions of other towns reside in the watershed upstream of Exeter, we are assessing their contributions to the impacts on the river system to provide a comprehensive analysis and management strategy. **Our project goals are to:** 1. Develop a science-based, integrated climate change adaptation strategy for this section of Exeter NH with a focus on the four intertwined problems, and 2. Implement, evaluate, and document the collaborative planning process and share the project results as a model for the region and nation.

Our major short-term goals for this period as reported in our last progress report and our progress towards them are below.

Engagement (details in Section B)

- Technical Outreach: This has continued during this period in particular with regular meetings with the Exeter River Study Committee of the town and the Town Planner.
- Communities of Interest: Much progress has been made.
- Broad Community Conversation Event: This was extremely successful.
- Citizen Working Group (CWG): This has had several meetings.
- Communities of Place: These meetings have not been held yet; the place-based vulnerability assessment has not been completed yet.

Applied Science (details in Section C)

- Install storm water and water quality monitors: Completed.
- Calibrate and verify the hydrologic, hydraulic, and water quality models: Ongoing.
- Develop the land use and climate change scenarios: Ongoing.
- Carry out the vulnerability assessment: Not yet started

B. Working with Intended Users: Describe the progress on tasks related to the integration of intended users into the project for this reporting period, What did you learn? Have there been any unanticipated challenges or opportunities? Who has been involved? Has interaction with intended users brought about any changes to your methods for integration of intended users, the intended users involved, or your project objectives? How do you anticipate working with intended users in the next six months?

- **Describe the progress on tasks related to the integration of intended users into the project for this reporting period.**

Overall, we have made significant progress on integrating intended users into the project (details provided below).We held a Community Conversation on April 10, 2013, subsequently convened a diverse, 17-member "Citizen's Working Group" (CWG) that has met monthly with the project team since May 2013, and have been meeting with Communities of Interest.

On Wednesday April 10, we held our first community conversation in the Exeter High School Cafeteria. The event was titled, **Floods, Rains, and Rivers: *What does it mean to you to prepare Exeter for a changing climate*?** Over 60 individuals came together to discuss recent local flooding and extreme weather impacts, and barriers and opportunities to prepare for Exeter's changing climate. The individuals split into nine groups each led by a facilitator from NH Listens and a youth facilitator from Exeter High School to explore different issues and challenges facing the Exeter community. This event was designed as an opportunity for neighbors to talk with neighbors to identify local assets, local needs, and ideas to effectively plan for a changing

Figure 1. Participants worked in small groups to identify perceived vulnerabilities at the "Community Conversation" on April 10th.

climate. Participants were from local schools, a local retirement community, a few of the resident-owned communities, and involved or elected community leaders. Over 75 % of the participants in the evaluation survey agreed they would participate in another CAPE community meeting.

As a part of the April 10 event, each of the small groups spent several minutes studying a map of Exeter. Participants were encouraged to locate their homes and place of business and then to identify locations where they feel there are vulnerabilities for people, infrastructure, and natural resources. This information has helped the project team to focus the technical modeling and outreach on areas that are most relevant to the needs of the community. Many groups expressed that the general downtown area was at risk. In particular, the Loaf and Ladle restaurant, Swasey Parkway, the Exeter River, and Court Street were identified as areas of concern. Groups also expressed concerns about the Great Bridge and String Bridge, as well as the Great Dam. All of the groups commented in some way on flooding threats to wastewater management, water treatment plants, and/or pump stations. The reservoir on Portsmouth Avenue and the new groundwater treatment plant at Larry Lane were both concerns as they impact drinking water. Though less discussed, several groups identified the Route 111 area, Powdermill Road, and the Hayes Mobile Home Park as at-risk areas. Most groups also discussed areas of low-income and elderly housing as at-risk. Other concerns were related to water pollution and the importance of clean drinking water. As discussed below, these maps were further analyzed by the project team.

Convened in May, 2013, **the CWG** includes representatives from local government including from the Exeter Select Board, local businesses, non-profits, faith-based organizations, youth, Philips Exeter Academy, the River Study Committee, and residents of various neighborhoods. This group has been instrumental in guiding us on both socio-economic and technical aspects of the project.

For example, CWG members suggested that our future presentation of the Vulnerability Assessment (planned for fall 2013) be co-hosted by our team and a local civic organization called *We The People*, in order to emphasize community ownership of the process. This reflects one example of how we are iteratively revising our engagement plan according to feedback from intended users. The CWG also helped us to identify which groups are currently missing or under-represented in the process: residents of certain vulnerable neighborhoods where flooding risk is known to be high, First Responders, health/hospital personnel, families with very young children, the business community, and sports/recreation groups. We have revised our engagement process to include specific, targeted outreach to many of these groups since many of them were unlikely to attend public meetings.

The first CWG meeting in May reviewed the CAPE project. The CWG was introduced to the modeling process at the June 2013 meeting through a presentation and Q&A by Paul Kirshen. The CWG discussed climate change and land use scenarios at the July 2013 meeting.

Lastly, we have engaged the CWG in our spatial mapping activities. This is an extension and integration of the mapping exercise completed at the April 10 Community Conversation. We were fortunate to have a Winant Fellow, Keith Johnson, contribute to CAPE for his summer

project by transferring the spatial information from the paper maps to GIS format for analysis and visualization.

Community Conversation and later CWG participants were tasked to identify and mark areas of importance within the Town of Exeter relevant to three distinct vulnerability categories: People, Infrastructure, and Natural Resources. The GIS integration process yielded eight maps from which the data analysis was conducted. Ultimately, the eight layers were combined to produce three final maps, one for each of the vulnerability categories.

To provide visualization of the vulnerability, a "heat density" layer was created from each map to help visualize areas of greatest concern identified by participants. An example is in Figure 2. "Warmer" colors on the maps indicate increased group concurrence for each vulnerability category. For example, the String Bridge in downtown Exeter was identified as prone to flooding by every group and of importance in the category of People. This is noted on the map by the color red. Areas that are "blank" or "white" on the map are areas which participants did not identify vulnerability concerns. This does not mean they are not vulnerable areas; only that they were not indicated as such by the groups during the Community Conversation and CWG deliberations.

This series of GIS maps are being used to stimulate further two-way dialogue with the CWG and other groups about the location of vulnerable places, people, and infrastructure in Exeter. Additionally, the GIS analysis enabled us to begin developing a Social Vulnerability Index (SVI) aligning with statewide efforts through the NH Department of Environmental Services and the NH Department of Health and Human Services. An Ecosystem Vulnerability Index (EVI) is also being developed. These indices will serve as valuable inputs to the Vulnerability Assessment, as well as serving to anchor ongoing dialogues with end-users.

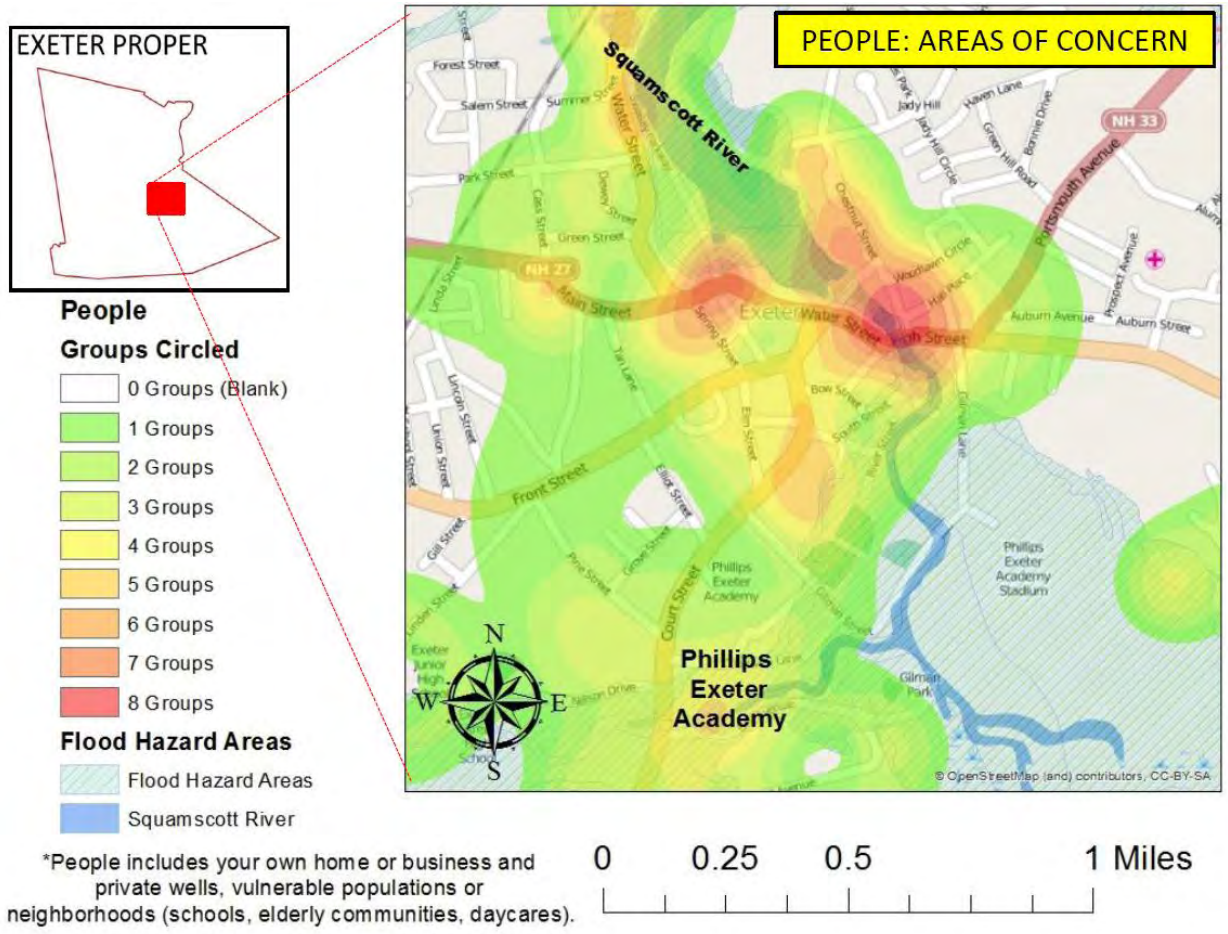

Figure 2. Example of Vulnerability Map

Two additional collaboration activities warrant mention. First, we developed and distributed a social network survey that will allow us to use social network analysis (SNA) to depict the current status of our partnerships and collaborative efforts. This analysis will also help us to determine how different partners are connected, which types of resources are most important to them and enable us to discuss ways to forge stronger connections as we move forward. Results will be available in early fall 2013.

Second, we made a decision to use qualitative analysis software (NViVO) to analyze the large volume of material that is being collected from our outreach activities. Several members of the Engagement Team were trained in the use of the software. This will enable us to analyze cross-cutting themes more efficiently with respect to the process embodied by the CAPE approach as well as the substantive concerns of project participants related to climate change. This will support a rigorous summative analysis of the project for dissemination in lay and peer-reviewed literature.

A **Community of Interest meeting** was held on Monday February 18 when two members of the project team were interviewed by two Exeter High School Students on the cable access television show, *Hawk Talk*. The students asked questions about the CAPE Project, the community

conversation on the 10, and other questions about climate change and climate adaptation. Other meetings are below.

On Thursday February 21, Paul Kirshen and Semra Aytur met with the Exeter River Study Committee to introduce the project, obtain feedback, and learn about other important activities (such as the Exeter Dam Study) that are occurring in parallel to the CAPE project.

On Tuesday March 12, NH Listens staff held a Youth Facilitator Training with ten Exeter High School students in Student Government and the student newspaper, *The Talon*. The focus was on specific skills useful for taking notes, encouraging participants to explore an idea or a disagreement, and making sure everyone is participating. In the end, 10 students served as co-facilitators for the April 10 event and two of these students went on to serve on the Citizen Working Group.

On Wednesday April 10, we held our first community conversation (described previously).

On Thursday April 18, Paul Kirshen and Semra Aytur met with the Exeter River Study Committee to present the preliminary results of the April 10 Community Conversation.

On Monday May 20, Michele Holt-Shannon presented to the Exeter Select Board and shared a summary of themes raised by participants of the April 10 event.

Clean Air- Cool Planet had a "lunch and learn" session with Exeter businesses on July 1.

On Wednesday August 7, Steve Miller and Michele Holt-Shannon met with Richard Belshaw from a local, ecumenical group called *We The People*. This group routinely hosts speakers and movies and discussions about ethical and moral issues of our time. We are currently planning to co-host an event with this group in the fall.

- **What did you learn? Have there been any unanticipated challenges or opportunities?**

Below we describe the outreach activities that did not go as smoothly as initially planned, and how we hope to address them. For example, representation with local business leaders was low at our April 10 public meeting, so we partnered with Roger Stephenson of Clean Air- Cool Planet who already had established connections with the business community locally, regionally, and nationally. Roger organized the informal "Lunch & Learn" event for Exeter business leaders, held on July 1, 2013. Additionally, a Clean Air-Cool Planet summer intern (Megan Barry) conducted a survey of businesses and compiled a final report. Excerpts below from the report highlight the challenges and lessons learned from this process:

"The survey results re-iterate that business owners are often too busy to be deeply engaged in this discussion. Overall, I believe one of the most important things moving forward will be to build the discussion and awareness, and this can be most effectively done through first-person contact in the form of workshops, or the organization of a panel of NJ businesses impacted by Hurricane Sandy."

Business owners were found to be more concerned about immediate, short-term issues (e.g., keeping the business solvent over the next few months) rather than with long-term issues such as climate change adaptation. As we move forward, Roger Stephenson will work with the CAPE team to plan more targeted events similar to the Lunch & Learn.

A second group that has not been well-represented is the First Responders and hospital/health sector. To engage these groups, the engagement team worked over the summer to plan targeted outreach to these groups. Sylvia von Aulock (Town Planner) was tremendously helpful by activating her local professional network of contacts with these groups. Together with Sylvia, our engagement team has planned fall events to specifically meet the needs of these groups.

Third, through the mapping exercises and conversations with the CWG, we identified specific neighborhoods and housing/apartment complexes that are vulnerable to flooding now. Our engagement team has planned door-to-door outreach to reach out to these and other vulnerable residents this fall after the climate change vulnerability modeling has been completed.

Other perspectives that were previously missing, such as representation from youth organizations and Philips Exeter Academy (PEA) are now better represented as a result of recruiting new members to the CWG. As the project evolves, we will determine whether we need to plan targeted outreach to these groups, as well.

Another challenge we discussed at our June 2013 Full Team meeting was the need to revise our current internal (team) communications and meeting structure. Because every member of the team was working hard on their respective pieces (e.g., technical modeling, outreach) we found it was becoming increasingly difficult to keep each other abreast of current activities. To address this, we made the following changes:

1) We now post weekly summaries of the Engagement Team and Technical Team's activities to Basecamp, along with a schedule of weekly events.
2) We committed to utilizing Basecamp more effectively and posting material more regularly.
3) To keep our Exeter partners fully informed without overburdening them with meetings, our Engagement team agreed to have conference calls with Sylvia Von Aulock every other week regarding engagement activities.
4) Since several team members expressed concerns about meeting structure and use of time, we decided to use facilitators for internal Full Team meetings from now on. The facilitator role will be shared and rotated among different team members who have facilitation experience.
5) We decided that Michele Holt-Shannon (NH Listens/Carsey Institute) will help to coordinate public communication activities with our Exeter partners.

It has become clear to both the research team and the CWG that the technical aspects of the modeling and the project as a whole are going to be a significant challenge to communicate. The CWG struggled with understanding the basics of the models and how they operate. It has

taken several meetings to achieve an operational comfort with the models and science involved in the project. The lesson here that was captured by and expressed by the CWG was that if they were having trouble with getting their hands and minds around the science, then the CAPE project needed to work very hard to find ways to clearly and simply communicate the science and results to Exeter. The CWG was also challenged to understand what the CAPE Project could and could not accomplish. The CWG is a diverse group with diverse interests. Their gaining a good functional understanding of the limits of the project is not easy because their passion for specific interests outside of the scope of this project are not easily left out of their views and perspectives. This is of course both positive and negative; negative as it diverts limited CWG time to issues we cannot address but positive because it will hopefully open doors to integrating CAPE results into broader Exeter social and environmental issues.

- **Who has been involved?**

This has been discussed in the previous section.

- **Has interaction with intended users brought about any changes to your methods for integration of intended users, the intended users involved, or your project objectives?** Many of the interactions have resulted in project adjustments, most of which have been described above. In addition, at the August 1 meeting of the project team, the issue of "translation" and keeping our communications clear and accessible was discussed. The team decided one of us will serve as the ombudsman/woman for the continual need for translation (e.g., translating the technical/modeling data into understandable language).

- **How do you anticipate working with intended users in the next six months?**

    - Neighborhood Meetings/ Communities of Place. As the technical team completes the current phase of modeling and identification of vulnerabilities, we will schedule 4 or 5 community conversations in neighborhoods or communities of place.

    - Exeter Select Board. One or two team members will continue to report out to the Exeter Select Board, briefing often during the Citizens' Forum, and sometimes formally on the agenda. These meetings are televised and broadcast on the community station.

    - Community Meeting. This meeting will be held in mid November to discuss the results of the climate change vulnerability assessment.

    - Project Advisory Committee. The Project Advisory Committee provides high-level reviews of the project and its relevance to other NERR sites. Members presently include Dr. Herman Karl, Dr Samuel Merrill, Dr Stacy Langsdale (expert in Participatory Modeling and Planning), Cory Riley (Manager of GBNERRS), and representatives from Narragansett Bay, Waquoit Bay, and Wells NERRs. The first meeting is planned for October.

- Knowledge Exchange Workshop to Enhance Community-Based Planning for Climate Change. Using a competitively awarded grant from the National Estuarine Research Reserve System Science Collaborative Transfer Request for Ideas (TRFI), engagement team members will be having a workshop in Delaware in Winter 2013-2014 to share experiences on community based adaptation planning. Delaware attendees will include DNERR, Delaware Management Coastal Program, DNREC Division of Climate and Energy, Delaware Sea Grant, and appropriate community decision makers.

C. Progress on project objectives for this reporting period: Describe progress on tasks related to project objectives for this reporting period.What data did you collect? Has your progress in this period brought about any changes to your methods, the integration of intended users, the intended users involved or the project objectives? Have there been any unanticipated challenges, opportunities, or lessons learned? What are your plans for meeting project objectives for the next six months?

Because material on working with intended users has been addressed on the Section B, this section covers the technical work. This multi-member team talks approximately weekly and has in-person meetings about every 3 weeks. We are building 4 major models to accomplish the project goals and provide material to intended users; HSPF to model in the entire basin monthly flows and water quality, river flood flows due to rain on snow events, and low flows; HEC-HMS and HEC-RAS to model precipitation-driven river flooding; SWMM to model storm water management in detail in Exeter and the lower portions of the basin; and a conceptual process model to analyze climate change impacts on aquatic ecosystems. In addition, scenarios of land use and climate change from 2010 to 2100 are being prepared.

- **Progress on project objectives for this reporting period**

Our first major goal is to calibrate and verify the models for the Exeter/Squamscott Basin, This effort is about one month behind due to delays in obtaining input data and the complexity of HSPF. The models will be presented and discussed with the CAPE Engagement Team and CWG over the next two months. The development of each model is complex. For example, Figure 3 shows the stormwater drainage infrastructure being modeled for downtown Exeter and Route 108 commercial district. Figure 4 shows the preliminary calibration of the flood model for Exeter.

Figure 3. Stormwater drainage infrastructure base map for downtown Exeter and Route 108 commercial district

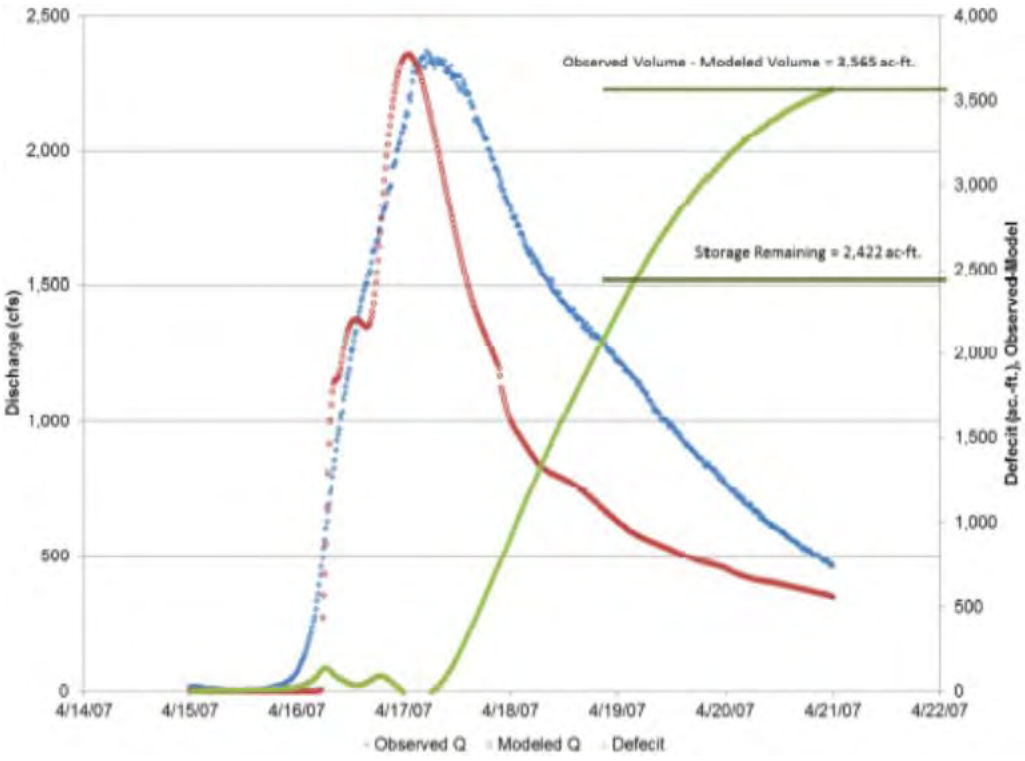

Figure 4. Partial Calibration of Flood Model at USGS Haigh Road Gage

The parameterization of the ecosystem process model cannot be carried out until the models above are functioning.

Preliminary decisions have also been made on the process of vulnerability assessment. For each of the hydrologic/hydraulic/water quality conditions of concern, three actual time series of scenarios of future daily precipitation (P) and max and min temperature (T) will be used to provide an envelop of high and low climate change and one moderate change. The scenarios will be selected from the several climate change emission scenarios and downscaled General Circulation Models used in the IPCC Fourth Assessment in 2008 (so-called CMIP 3 runs).

After some hydrologic modification to derive, for example, hourly precipitation from the daily precipitation, the water models will be driven separately with the three time series from the present to 2100. Since 30 years is generally considered to be representative of climate conditions, the results can be sorted by continuous 30 year periods to determine the climate change impacts over time. This method will also allow us to determine the values of the climate conditions and associated hydrologic and water quality conditions when critical conditions occur in the watershed. Critical conditions will be determined by both interaction with the intended users and engineering analysis.

Some of the newer climate change projections being used in the 2013-2014 IPCC Assessment (CMIP5) will also be experimentally tested in the models.

- **What Data did you collect?**

To assist in future model calibration, monitoring data have been collected at several locations within the sewershed over the course of the summer (see Table). These data consist of water surface depths within select catch basins and also locations in the tidal portion of the Squamscott River. The data have been retrieved from the sensors and processed into a format suitable for model calibration. The processed data are in the form of continuous depth and/or discharge hydrographs, which will be directly comparable to model output.

Location	Name	Parameter
1	Park Street	Depth (Flow)
2	Summer Street	Depth (Flow)
3	Tan Street	Depth (Flow)
4	Great Dam	Depth (Flow), Conductivity
5	Squamscott River	Depth (Flow), Conductivity

Table 1: Locations and parameters of monitoring locations to be used for model calibration and verification

The CAPE project worked with the Tier 1 EPSCOR project at UNH to obtain a pair of data loggers and deployed them upstream (fresh) and downstream (tidal) of the Great Dam in early July 2013. These instruments measure specific conductivity, salinity, water temperature and depth at 4-minute intervals and will be used for the next year as part of the state-wide EPSCOR sensor network of ~300 sensors tracking ecosystem and climate change. Grab samples of water were also collected on July 16, 2013 as part of the EPSCOR state-wide "Snap Shot" sampling event for nutrient and isotope analyses. These data will allow us to gain a better understanding of water temperature and specific conductivity/salinity, and key ecological conditions.

Existing data from ongoing and recent other studies have also been compiled to inform the modeling efforts and provide a basis for framing ecosystem conditions and future concerns. The data include measurements of water temperature, salinity/specific conductivity, pH, dissolved oxygen, nutrients, fecal-borne bacteria, suspended solids, chlorophyll a, and toxic chemicals. The data have been compiled from the NH DES Ambient Tributaries and VRAP programs, NH Sea Grant Coastal Research Volunteer Program storm drain monitoring, an extensive study in the Exeter-Squamscott River in 2011 funded by the Great Bay Municipal Coalition, the EPA/NHDES National Coastal Condition Assessment Program, and the GBNERR SWMP program. Older datasets are also available through various studies by UNH Jackson Lab and NH Fish & Game Dept. Ongoing monitoring throughout the Exeter River watershed by the McDowell Lab at UNH are not yet available but will eventually be utilized.

- **Has your progress in this period brought about any changes to your methods, the integration of intended users, the intended users involved or the project objectives?**

There have been no changes.

- **Have there been any unanticipated challenges, opportunities, or lessons learned?**

No challenges have presented significant obstacles. The two primary challenges include: 1) the time consuming element of revisions of technical methods based upon community and project team feedback, and 2) managing expectations for project team and community. The technical methods are often far more limited in application than some project team and community members realize. As an example, we often hear about concerns of groundwater contamination from a junkyard, and concerns about wet basements. The technical models, focusing primarily upon other issues, will only enable us to qualitatively analyze these items.

- **What are your plans for meeting project objectives for the next six months?**

We plan to have the models calibrated and verified by mid- September and then complete the modeling for the vulnerability assessment by end of October so the results can be presented to the community and Project Advisory Committee close to that time. Engagement will then focus upon communities of place as the CAPE team develops adaptation possibilities to analyze.

D.Benefit to NERRS and NOAA: List any project-related products, accomplishments, or discoveries that may be of interest to scientists or managers working on similar issues, your peers in the NERRS, or to NOAA. These may include, but are not limited to, workshops, trainings, or webinars; expert speakers; new publications; and new partnerships or key findings related to collaboration or applied science.

- The previously described enhanced vulnerability maps of People, Infrastructure, and Natural Resources, the upcoming workshop with Delaware NERR, and the Clean Air-Cool Planet final report on businesses and climate change concerns in the region.

- Abstract accepted by American Public Health Association Annual meeting , Boston, MA, November, 2013, Community engagement for climate-ready communities: The role of community based participatory research (CBPR) in local climate adaptation planning and evaluation.

- Abstract submitted to the Fall 2013 AGU Conference, Development of an Integrated Water Resources and Coastal Adaptation Plan for Exeter NH: Phase 1, Vulnerability Assessment.

E.Describe any activities, products, accomplishments, or obstacles not addressed in other sections of this report that you feel are important for the Science Collaborative to know.

None to report.

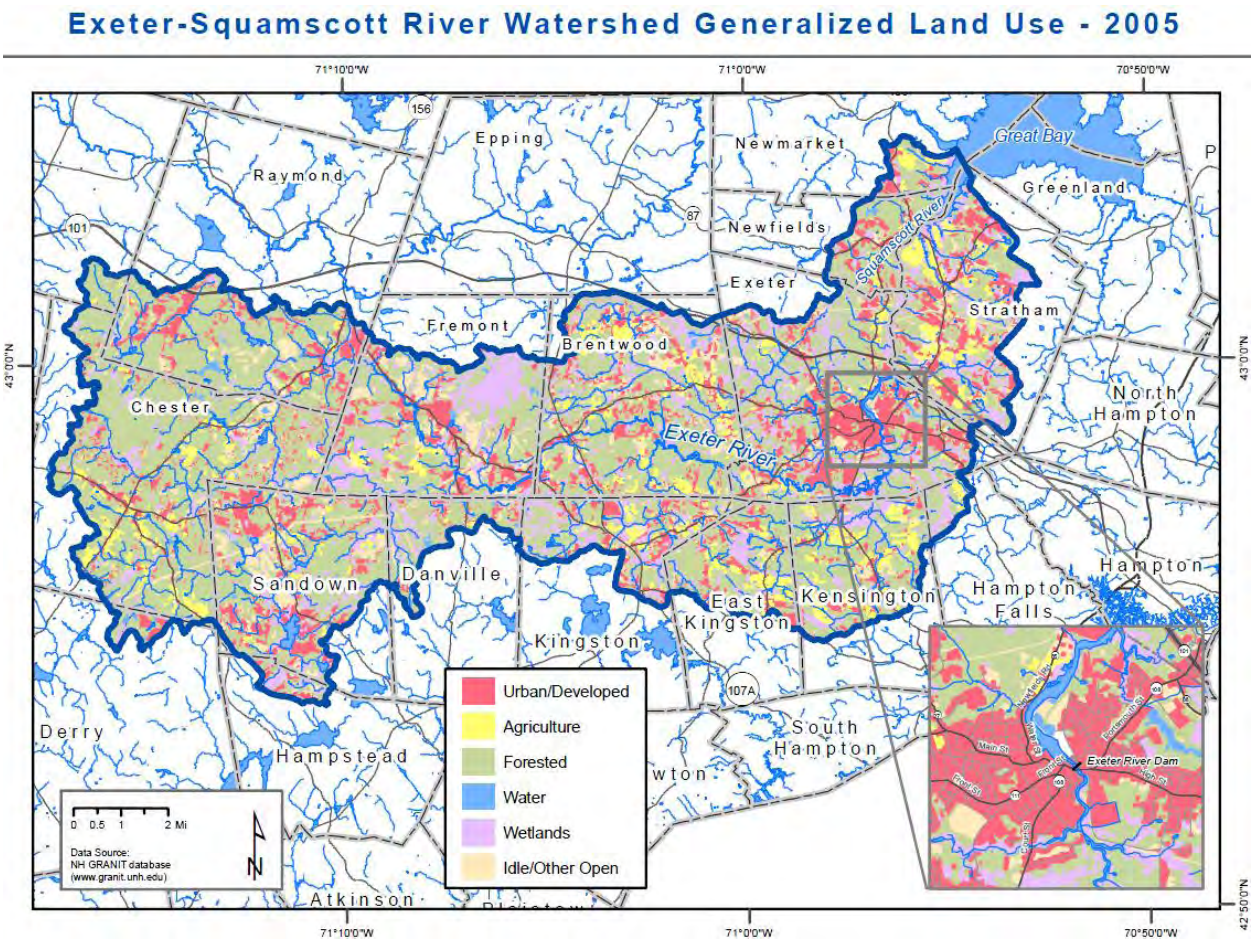

Figure 1. Project Site.